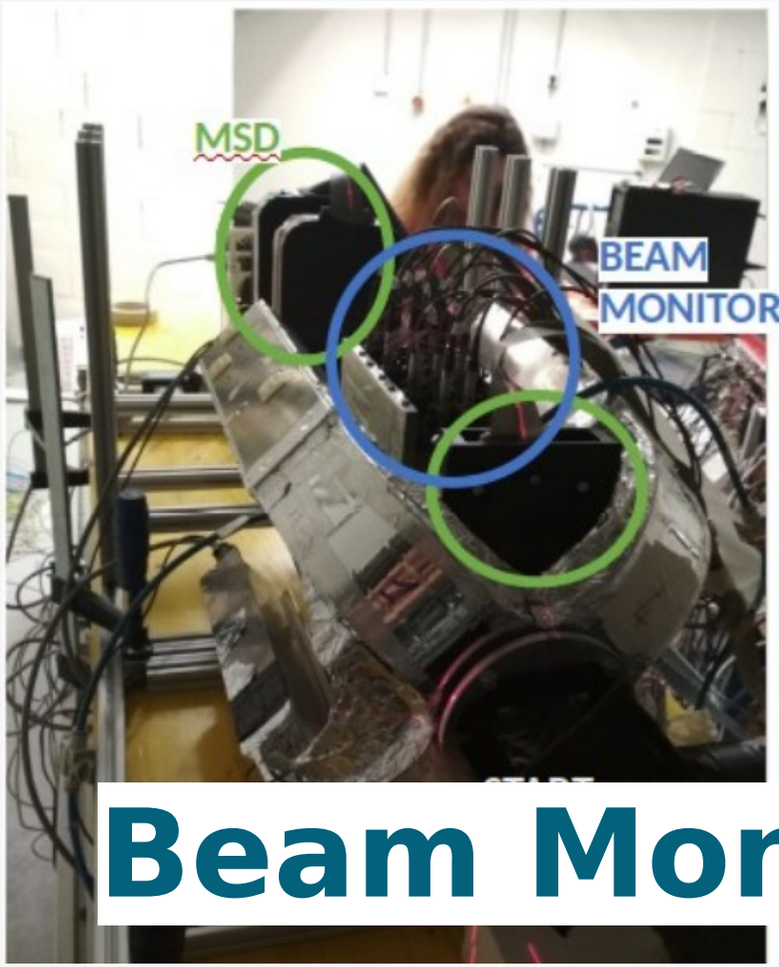
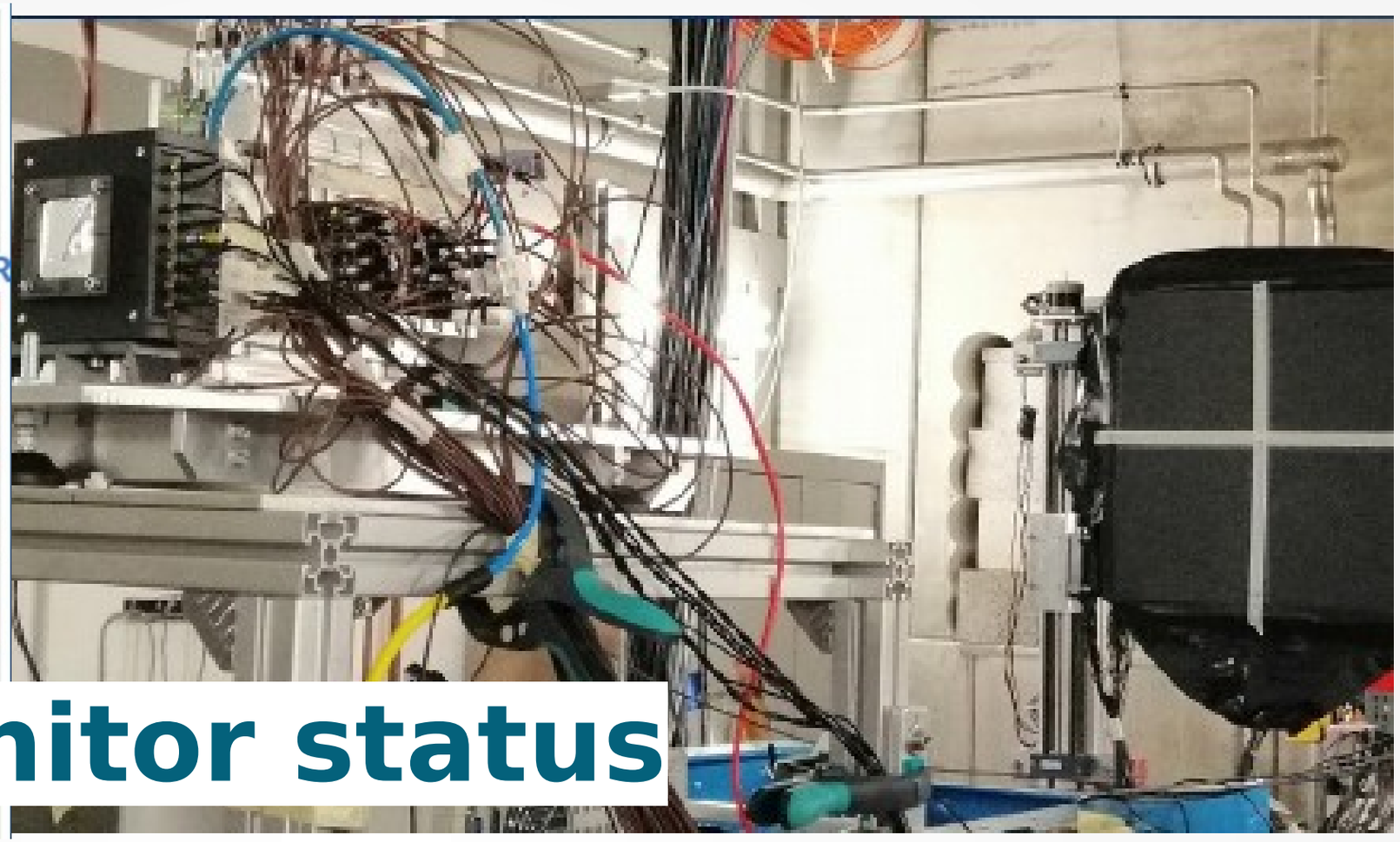




Beam Monitor status

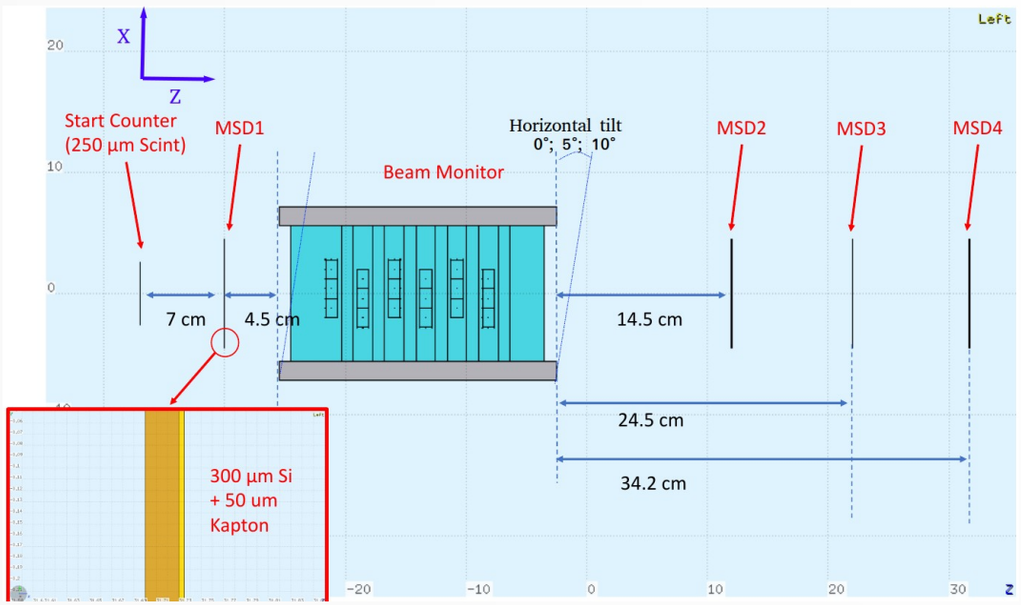
Milano + Trento + Perugia

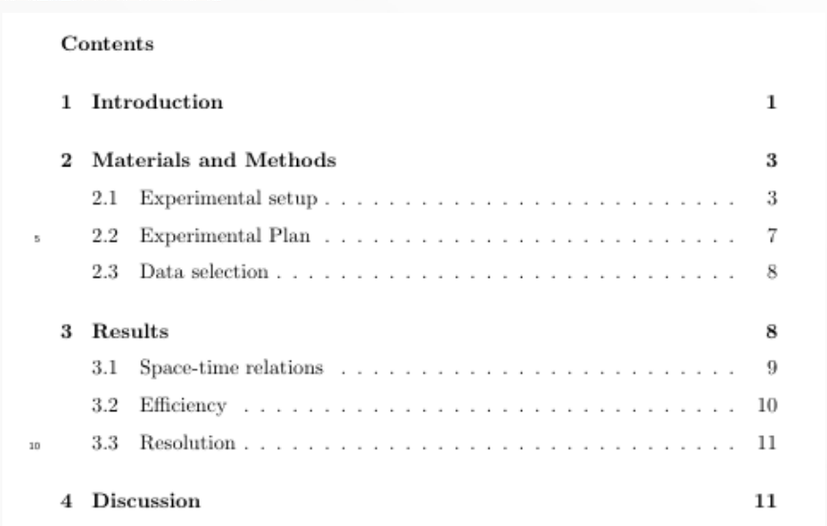
Generale FOOT meeting
04/12/19

Outlook

- Calibration test @ Trento: results and paper
- Iterative and Legendre hit selection algorithms
- New track reconstruction based on chi2 minimization and ROOT Minuit2
- Update on BM @ GSI with the electronic setup
- To do list

BM calibration with P @ Trento



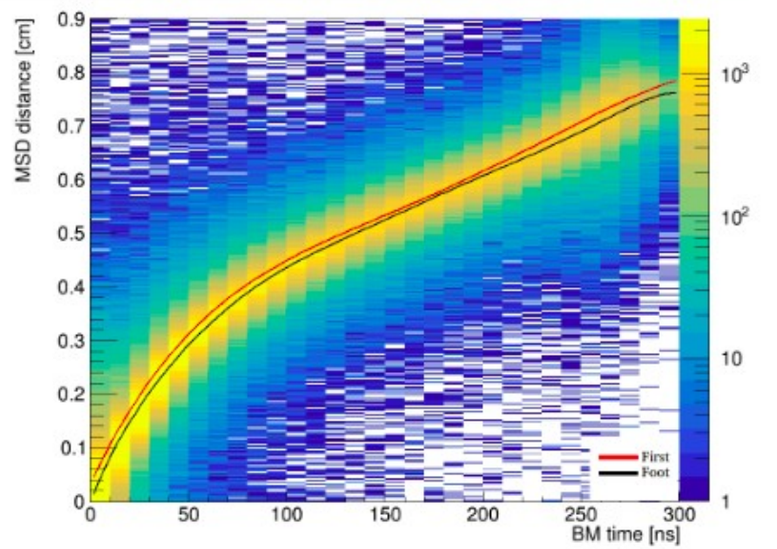


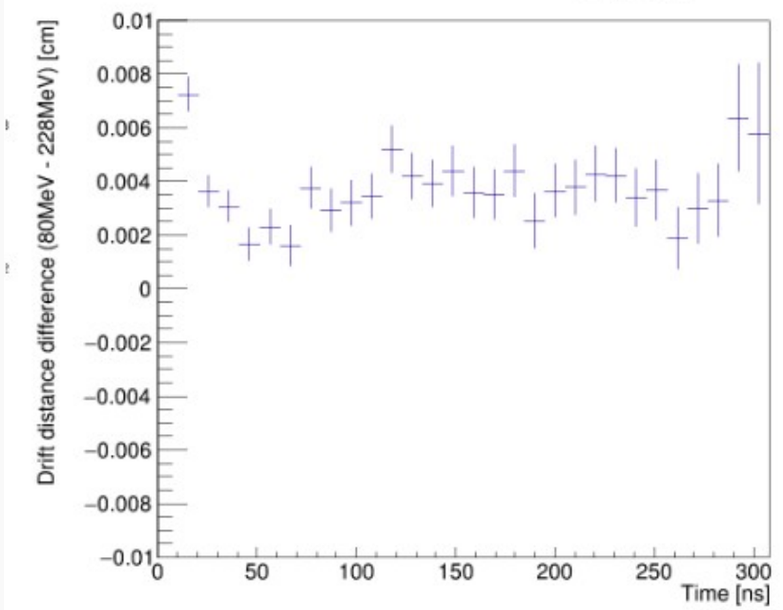
Contents

- Calibration test performed with Margherita and 4 layers of Microstrip Silicon detectors (MSD), together with the Perugia Team.
- Several noisy and dead strips (up to 4 points on X coordinate and 3 on Y coordinate)
- Multiple Coulomb scattering evaluation ongoing
- **Technical paper in preparation (NIM)**

Collected data:
200 kevt.: 80 MeV, 0° tilt
100 kevt.: 228 MeV, 0° tilt
100 kevt.: 80 MeV, 5° tilt
100 kevt.: 228 MeV, 5° tilt
100 kevt: 228 MeV, 10° tilt

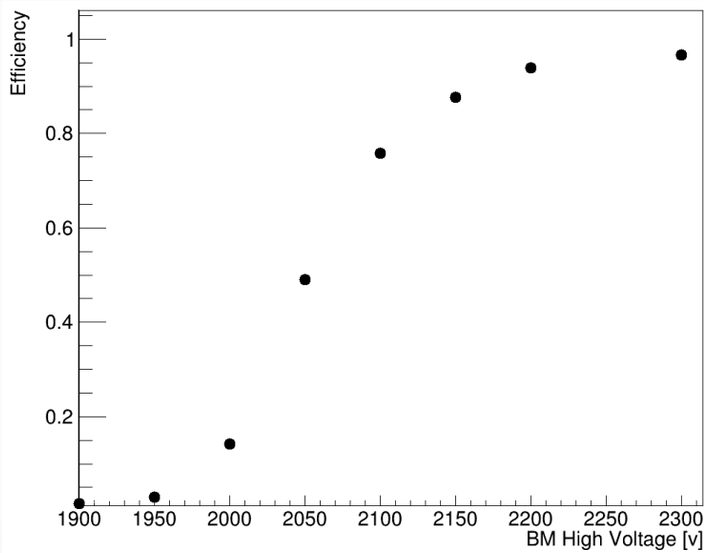
Preliminary results: Space-time rel

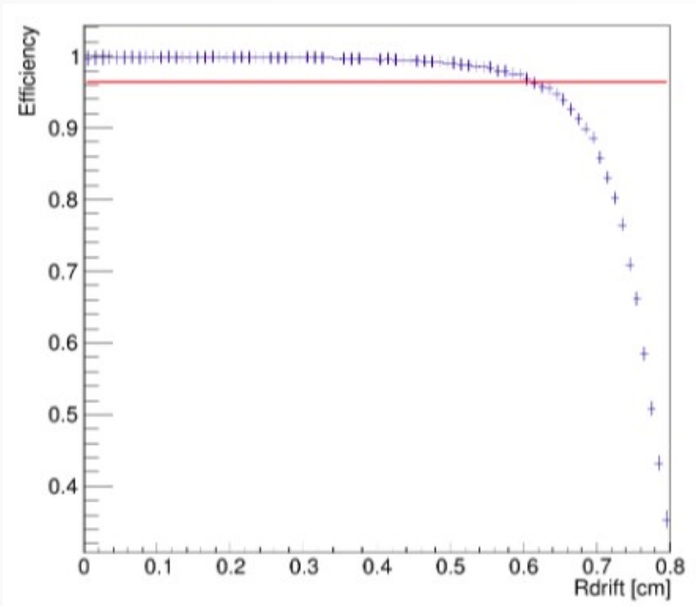




- Space time relations evaluated with the BM time and the MSD tracks extrapolated to the BM sense wire position
- Similar Space-time rel. as in FIRST, even if it was evaluated with C @ 80 MeV/u and with different BM working point (HV, pressure, gas)
- Difference between 80 and 228 MeV protons probably given by the different mean free path between two ionisation clusters
- **MC Garfield++ simulation studies ongoing**

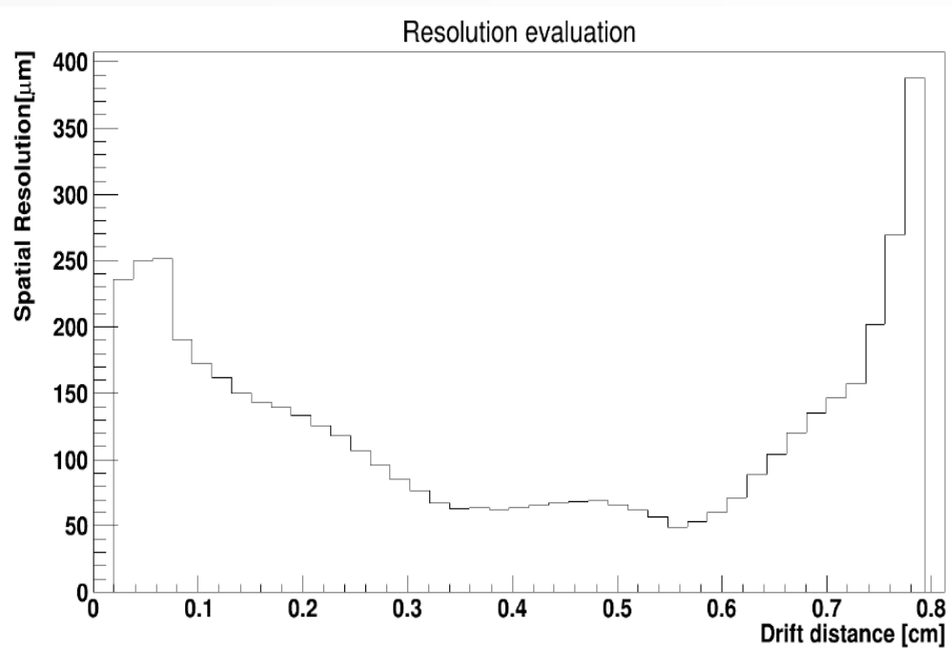
Efficiency





- Hit detection efficiency evaluated as fraction of events with one or two hit detected on even (odd) planes, when three single hits on odd (even) planes have been scored.
- HV efficiency scan previously measured compatible with FIRST measurement
- MSD track extrapolated to the BM cells and check if there's a hit or not.
- **The BM is inefficient at the cell border**, where the Electric field is weaker
- However the BM cells are staggered: the cell border of one layer correspond to the cell center on the next layer

Resolution



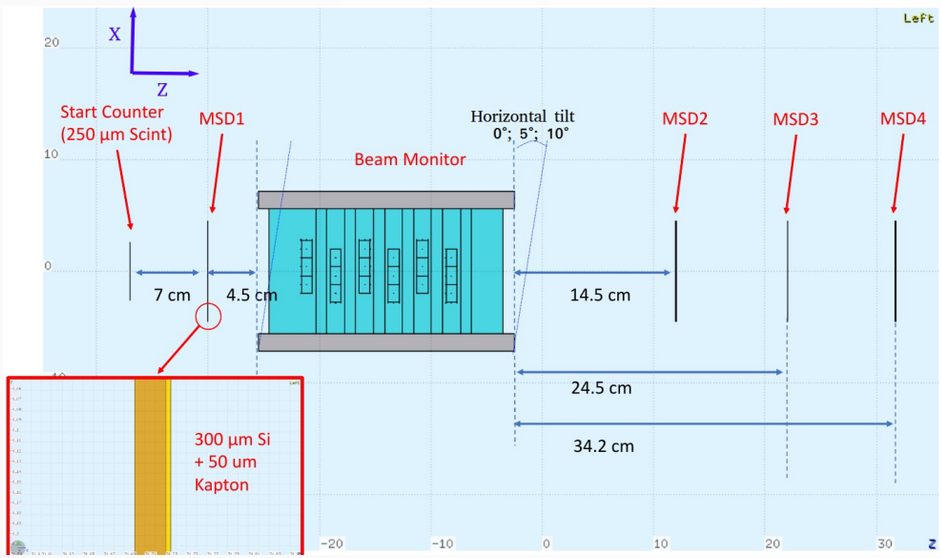
Method 1:

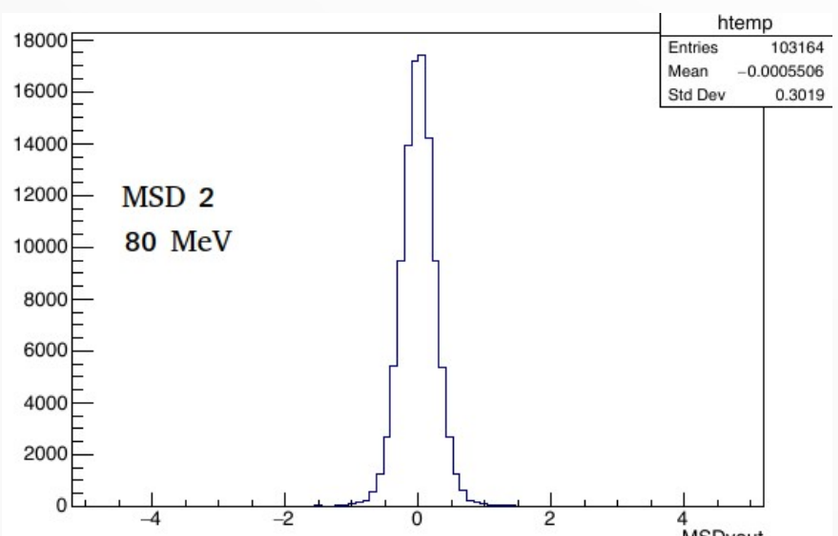
- Using only the BM hits and tracks, the resolution can be evaluated as the residual between the BM fitted track and the hits measurement.
- The result is in a good agreement with the performances measured in FIRST
- Depends on the BM reconstruction algorithm and selection criteria.

Method 2:

- Evaluate the residual using the MSD tracks and the BM hits.
- No dependence on BM reconstruction, but MSD resolution and Multiple Coulomb scattering have to be evaluated properly

Multiple Coulomb Scattering



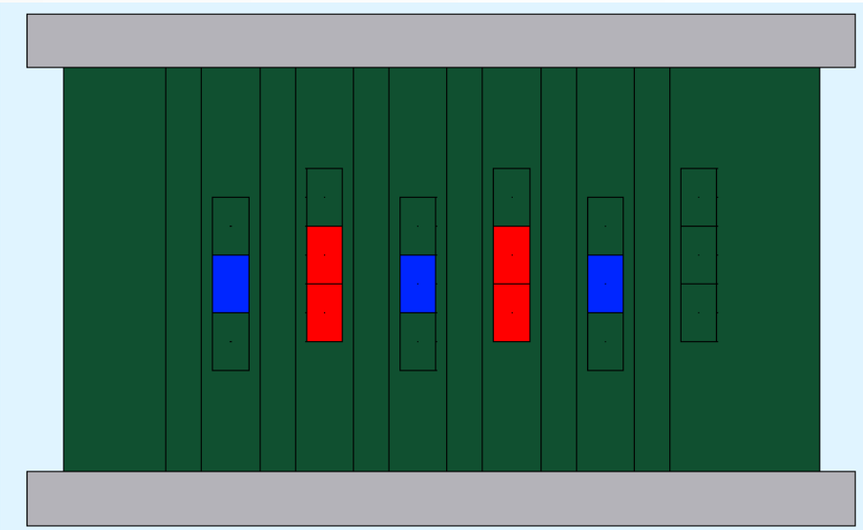


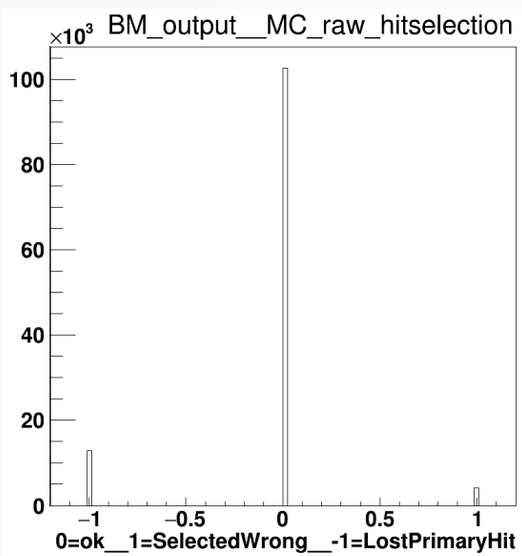
- The Multiple scattering given by the MSDs (300 µm of Si + 50 µm Kapton) is relevant.
- From FLUKA simulation of a pencil beam:

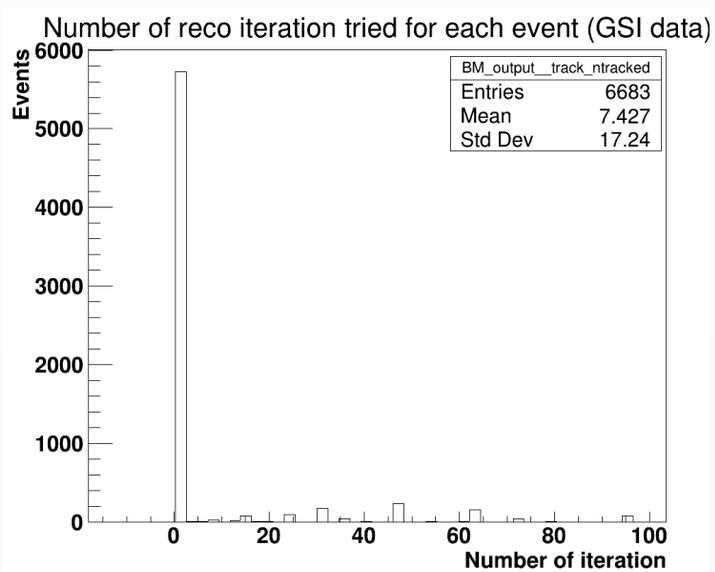
	Std. Dev. [cm] 80 MeV	Std. Dev. [cm] 228 MeV
MSD1	0.076	0.059
MSD2	0.3	0.13
MSD3	0.38	0.17
MSD4	0.46	0.2

- The evaluation of the MCS on data is ongoing
- Possibility to minimize it using the hits only from the first two MSD planes
- **It could be an issue in FOOT?**
  (MSD with 150µm of Si + Vertex + IT)

BM hit selection: iterative algorithm



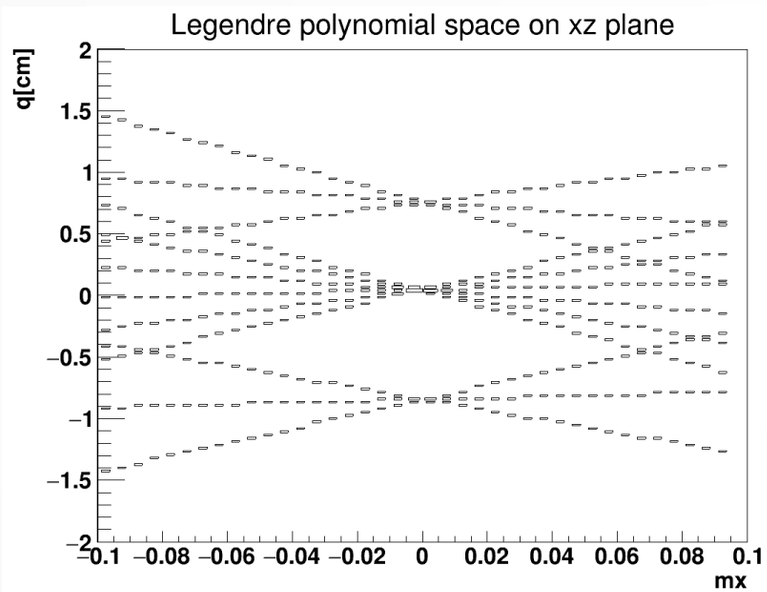


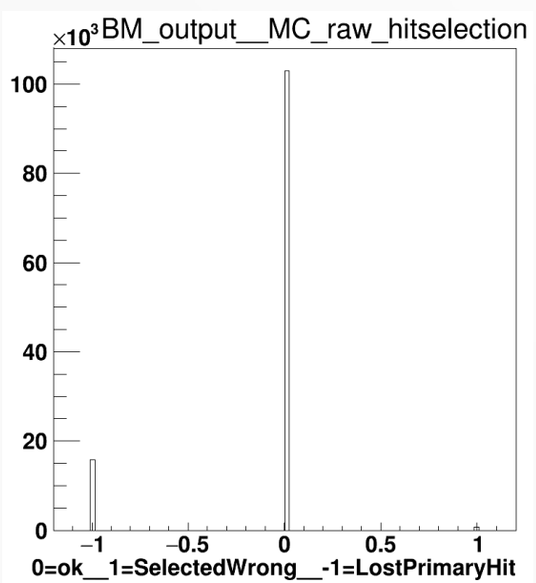


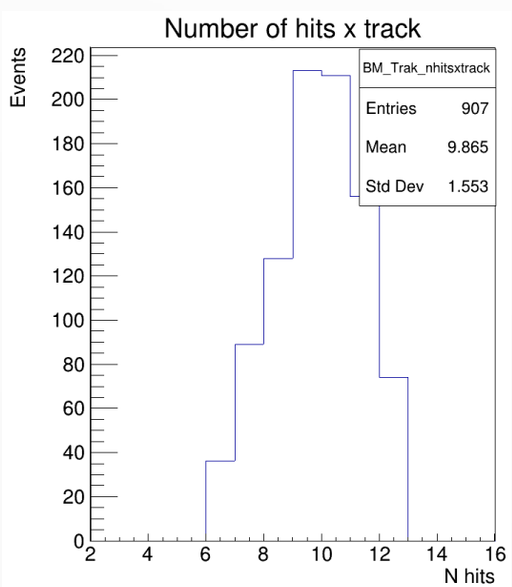
Iterative algorithm:

- Start taking into account only the planes with a single hit
- Evaluate the 4 possible tracks with the two farther hits
- Evaluate the residuals of the other hits, select the best possible track and associate hits with low residual.
- After the reconstruction, look for possible hit to be rejected
- If the reconstruction does not converge, evaluate all possible hit combinations

BM hit selection: Legendre transform



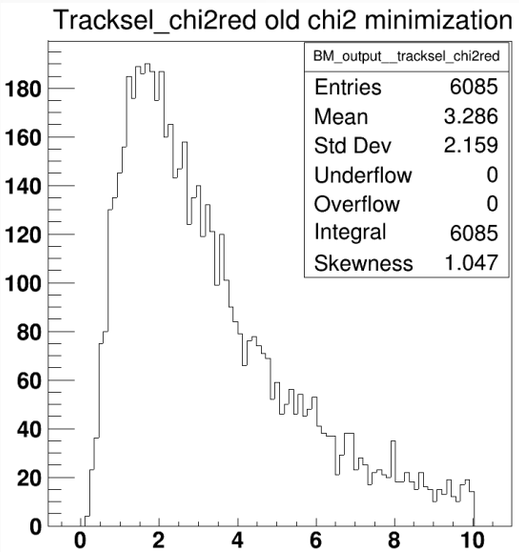


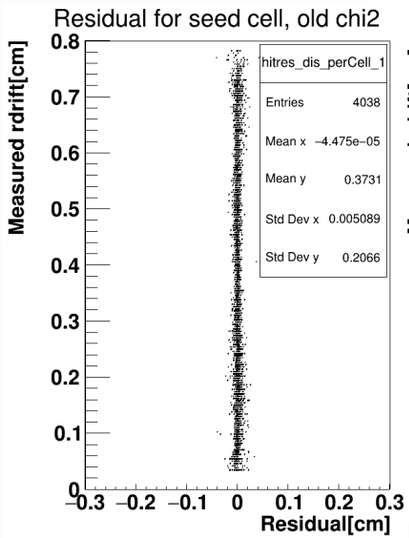


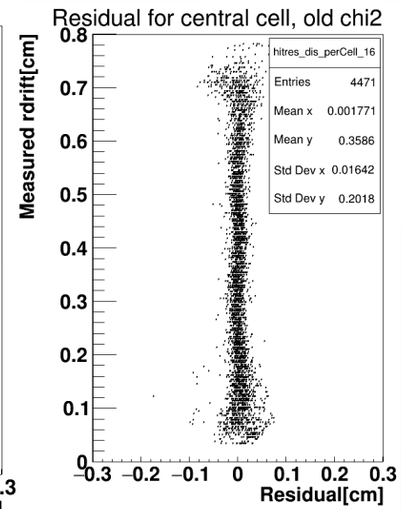
Legendre Transform:

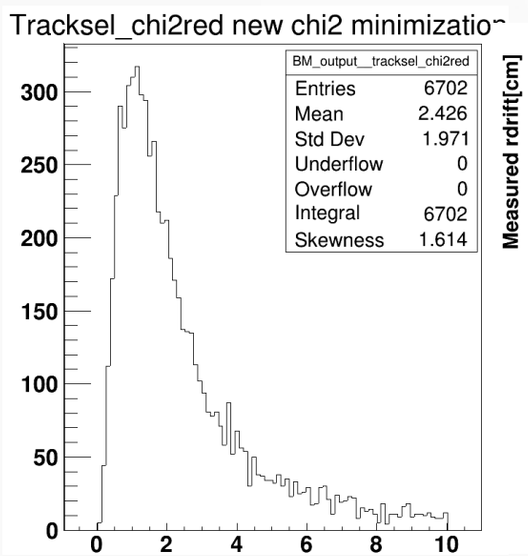
- Used for hit selection and first guess of the track parameters
- Avoid the iteration on different possible tracks due to the previous hit selection algorithm
- Works properly with the MC, but it needs to be optimized for the GSI electronic setup data.
- Need further analysis to be compared with the old iterative algorithm

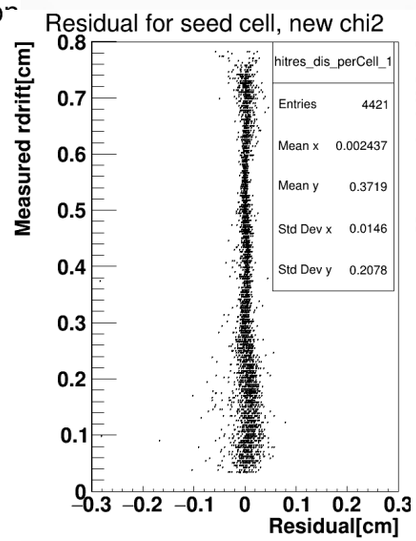
New BM reconstruction

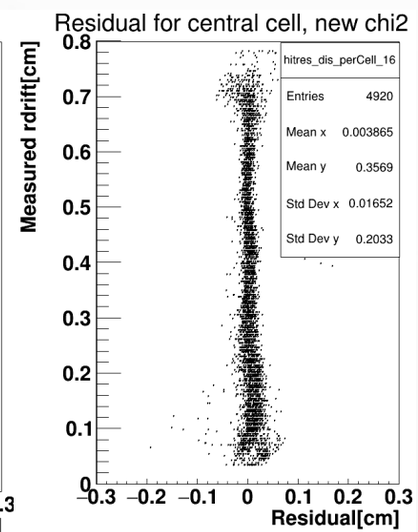










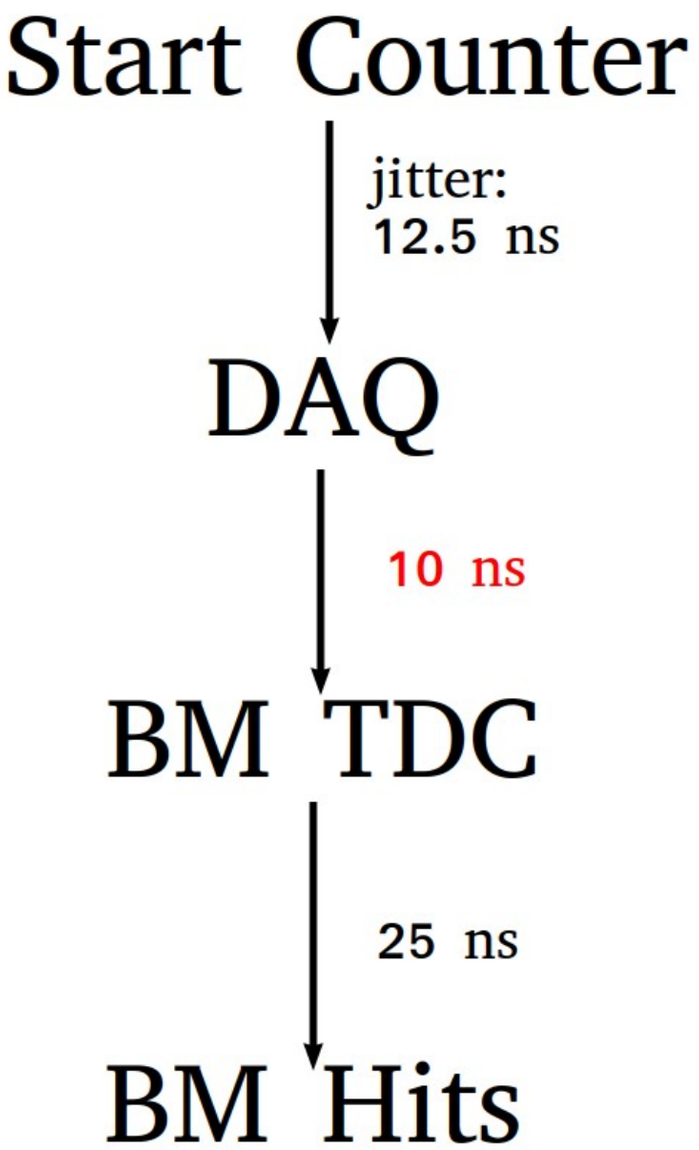


New chi2 minimization method based on ROOT Minuit2 package

- Reduce the number of iteration and the computation time
- Better time and reconstruction performances
- Less dependence on the initial track seed
- Minuit2 have to be enabled in the ROOT build dir:

cmake path/to/source -Dminuit2=ON -Drpath=ON
cmake --build .

BM trigger @ GSI



- From the arrival of the particle to the measurement of the BM cell signal there are different passages:

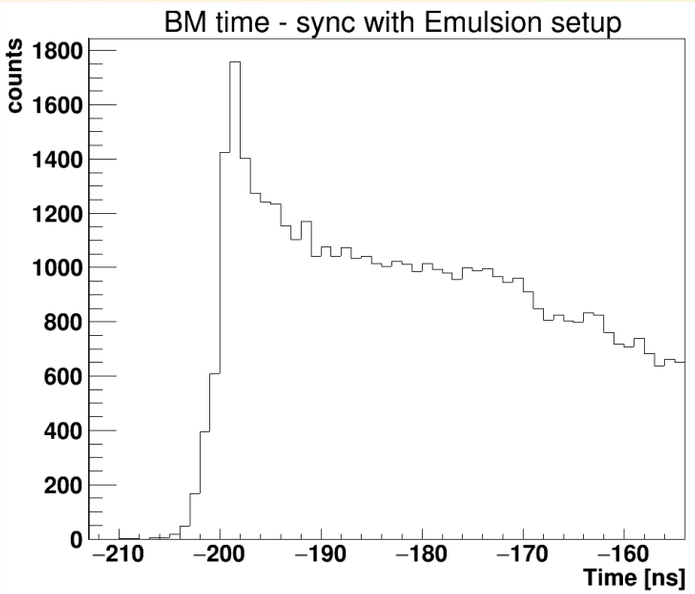
  1)A particle cross the Start Counter.

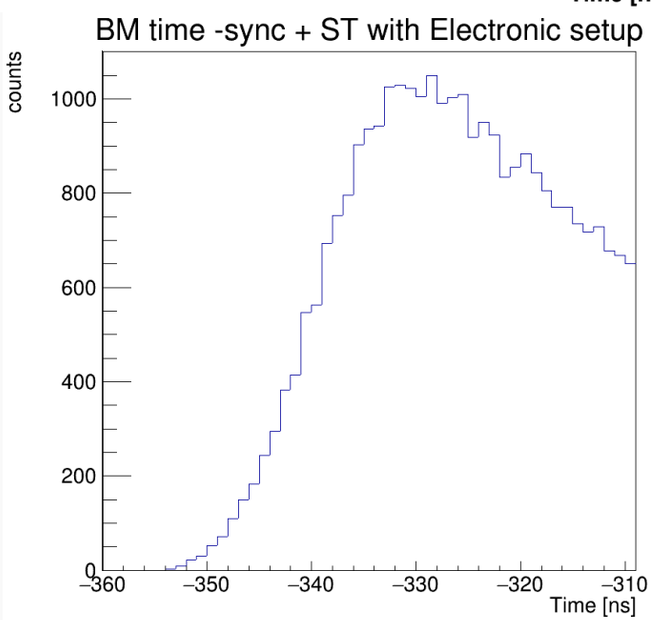
  2)The majority give a trigger signal with a jitter of 12.5 ns (measured by the WD).

  3)The signal is sampled by the DAQ and it is spread among all the subdetector with a jitter of ~10 ns **(Not measured).**

  4)The trigger give the start for the data transfer to the TDC with a jitter of 25 ns (measured by TDC).

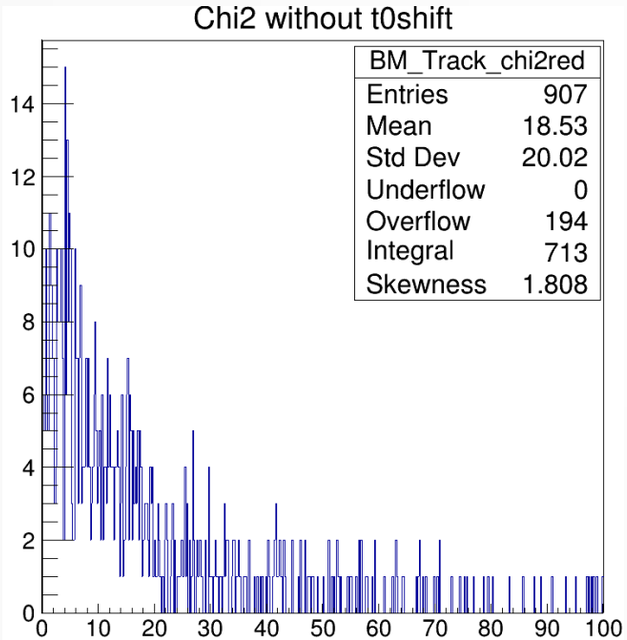
BM trigger @ GSI

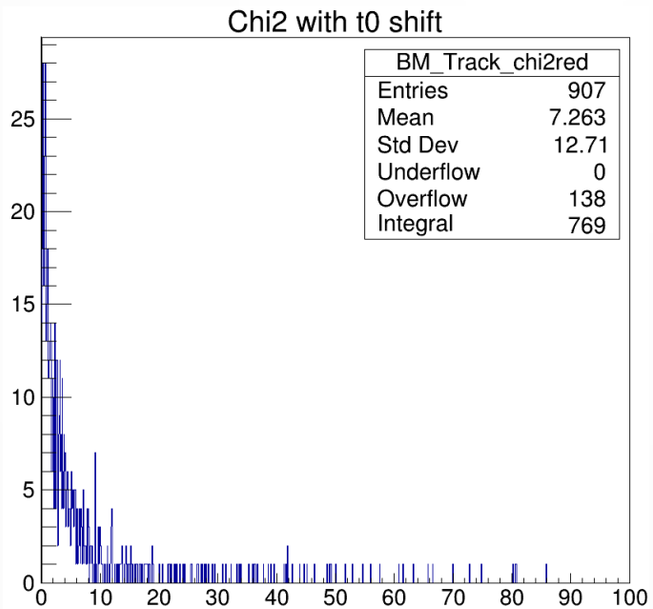




- The trigger signal from the SC to the DAQ is sampled every ~10 ns, resulting in a **shift of the BM hits time measurement**
- This is evident comparing the BM raw time measurements of a channel with the emulsion setup and the electronic setup.
- This issue must be fixed for the next electronic data taking (late 2020)
- For the GSI data it can be partially recovered in the track reconstruction

Gsi data recovery





- It is possible to shift the t0 for all the hit of an event to take into account the SC-DAQ jitter
- At the moment it is made simply reconstructing a track for each t0 step and selecting the best track
- Good recovery
- Not optimized
- Additional computational time
- Try to use multithread process

	BM process contribution	Cpu time (1000 evts)
Default:	1.6 %	139050
With t0 shift:	12 %	155990

To do list

Calibration test @ Trento

- Garfield++ simulation toolkit to check the Space-time relations
- Finalize the study on the Multiple Coulomb Scattering and the MSD track reconstruction and selection criteria.
- Evaluate the BM resolution performances using the MSD tracks and taking into account the MCS effect
- Evaluate the sense wire shifts with the MSD tracks

Reconstruction and software improvement

- Optimization of the Legendre transform and analysis with the old iterative method

GSI data

- Optimize and speed up the t0 shift reconstruction
- Analysis with vertex detector tracks

GSI emulsion setup